Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	**Materials science and structural mechanics**
Course code	42175
Scientific sector	ICAR/08 – ING-IND/22
Degree	Bachelor in Industrial and Mechanical Engineering
Semester	I
Year	II
Academic year	2023/24
Credits	12 (6+6)
Modular	*yes*

Total lecturing hours	76 (40+36)
Total lab hours	-
Total exercise hours	39 (15+24)
Attendance	Recommended
Prerequisites	None
Course page	https://www.unibz.it/en/faculties/engineering/bachelor-industrial-mechanical-engineering//course-offering/

Specific educational objectives	The specific educational objectives include the understanding and knowledge of the fundamentals of material science and structural mechanics. The students will learn mechanical properties of engineering materials and structural elements and how they may be analyzed. This includes modelling abstractions, solution methods and the interpretation of results of relevant engineering mechanics problems.

Module 1	**Mechanics of structures**
Lecturer	Dr. techn. Thomas Moosbrugger https://www.unibz.it/en/faculties/engineering/academic-staff/person/42499-thomas-franz-xaver-moosbrugger
Scientific sector of the lecturer	
Teaching language	German
Office hours	18h (by appointment: ThomasFranzXaver.Moosbrugger@unibz.it)
Teaching assistant *(if any)*	-
Office hours	-
List of topics covered	Core topics of the course (fundamental for the learning objectives and cultural project) • Equilibrium of forces with a common point of application, and of rigid bodies • Determination of support reactions and internal forces • Centre of forces, mass, and gravity

	• Elementary theory of tension/compression, bending, and torsion • Stresses, stress resultants, strains, and Hooke's law Complementary topics of the course • Buckling • Basic energy methods in statics and elastostatics • Kinematical and statical determinacy • Coulomb theory of friction, and belt friction • Thin-walled pressure vessels Complementary topics (not included in the course) • Elementary theory of plasticity • Analysis of thick-walled cylinders • Analysis of plates and shells • Composite sections
Teaching format	Frontal lectures, exercises

Module 2	**Material Science and Technology**
Lecturer	**Prof. Stefano Rossi PhD** stefano.rossi@unibz.it, and stefano.rossi@unitn.it, 0471-017092, https://www.unibz.it/en/faculties/engineering/academic-staff/person/1075-stefano-rossi
Scientific sector of the **lecturer	ING IND22
Teaching language	Italian
Office hours	18 h
Teaching assistant (if any)	n.d.
Office hours	Before lectures
List of topics covered	In the course the followings topics about materials will be considered. • **Introduction**: the materials and their use in the industrial production. • Technological properties of materials: different type of materials and their typical properties; • correlation between microstructure and mechanical properties; • basis of thermodynamics and equilibrium diagrams. • **Metals**: • characteristics and properties of iron alloys (steel and cast iron), • non ferreous metals. • **Ceramics and glasses**: • the production and utilization of ceramic materials; • the characteristics of glass; the production of glass components.

	• **Polymers:** production and properties of polymeric materials; • production of components in polymeric matter; utilization of polymers. • **The composite materials**: production, properties, utilization of composite materials. **Testing standard about of materials**:
Teaching format	Class lectures in which topics are presented by the teacher. The lecture topics will be arguments of exercises and practical activities explained by the teacher and the teaching assistants. Generally, PowerPoint presentations will be used during the lectures. The lessons will then be integrated with classroom exercises and video with comments. They will try to encourage students to independently perform some exercises as a self-learning test. The PowerPoint presentations will be given to students as material for the study track, for the preparation of the final examination.

Learning outcomes	**<u>Module I Mechanics of structures:</u>** <u>Knowledge and understanding:</u> 1. Knowledge and understanding of the fundamentals of structural mechanics. <u>Applying knowledge and understanding:</u> 2. Applying theoretical methods to analyze engineering structures and structural systems. <u>Making judgments:</u> 3. Analyzing structural engineering devices/systems requires a deep understanding and the ability to show judgment regarding methods, results and designs. <u>Communication skills:</u> 4. Communication skills to convey and transfer structural mechanics knowledge. 5. Communication skills to interpret results of structural mechanics analyses and their consequences with respect to design. <u>Ability to learn:</u> 6. Learning skills to study independently the large and complex field of structural mechanics for specific applications beyond this lecture. **<u>Module II Material Science and Technology:</u>**

	Knowledge and understanding: 1. Knowledge and understanding of the different properties of materials and different technologies and production processes. Applying knowledge and understanding: 2. Applying knowledge and understanding through the development of skills and the ability to choose the suitable materials and the technology for a particular industrial product. In addition, the students should develop the ability to apply the knowledge on the behavior of materials in the performance of laboratory technological tests. Making judgments 3. Connect the properties of different materials with their microstructure; capacity to evaluate the experimental data obtained in laboratory tests. Communication skills 4. Communication skills to present the acquired knowledge with their own lexicon of the discipline and to be able to prepare a technical report about materials tests. Ability to learn 5. Acquire skills to deepen the topics covered during the course in order to apply them to simple practical cases. 6. Acquire the ability to interpret experimental test data obtained in material characterization tests.

Assessment

Module I Mechanics of structures:
Formative assessment:

Form	Length /duration	ILOs assessed
Exercises in the lecture hall	In the process of the exercises sessions, 20%	1-5

Summative assessment

Form	%	Length /duration	ILOs assessed
Oral examination (in a small group)	80	60 min	1-5

Module 2 Material Science and Technology:
Formative assessment:

Form	Length /duration	ILOs assessed
Exercises in the lecture hall	In the process of the exercises sessions	1-5

Summative assessment:

Form	Length /duration	ILOs assessed
Written exam with questions and exercises	2 h	1,2,3,4,5

Assessment language

Module I Structural Mechanics: German
Module II Material Science and Technology: Italian

Evaluation criteria and criteria for awarding marks

Module I Structural Mechanics:
Written examination (in German) will include derivations and numerical examples to evaluate the ability to solve structural-mechanics problems as well as comprehension questions.

Form	Evaluation criteria and weight
oral exam	Theoretical knowledge (30%) Appropriate use of methods (30%) Ability to solve problems (30%) Appropriate use of units (10%)

Module II Material Science and Technology:
Written exam Theoretical knowledge of the subject (40%);
Ability to link different topics highlighting the similar peculiarities and characteristics (30%);
Ability to apply the concepts relating to materials and production technologies, for examples of objects and products (20%);
Mastery of technical language (10%).

Final mark:
50% Module I Structural Mechanics
50% Module II Material Science and Technology
Note: Students must pass both modules in order to pass this course

Required readings	Lectures notes. The slides, supplied during class, are a useful to follow the lectures and for the individual study. However, they are NOT sufficient for the successful exam preparation.
Supplementary readings	<u>Module I Mechanics of structures:</u> German: • Gross, D., W. Hauger, J. Schröder, and W. A. Wall (2013). Technische Mechanik 1: Statik (12 ed.). Springer • Gross, D., W. Hauger, J. Schröder, and W. A. Wall (2014). Technische Mechanik 2: Elastostatik (12 ed.). Springer. English: • Gross, D., W. Hauger, J. Schröder, W. A. Wall, and J. Bonet (2011). Engineering mechanics 2: Mechanics of materials (1 ed.). Springer. • Gross, D., W. Hauger, J. Schröder, W. A. Wall, and N. Rajapakse (2013). Engineering mechanics 1: Statics (2 ed.). Springer. Italian: • Curti, G. and F. Curà (2006). Fondamenti di meccanica strutturale. Clut. Further literature will be discussed during the lectures and exercises. <u>Module II Material Science and Technology:</u> • William F. Smith "Scienza e Tecnologia dei Materiali" Mc Graw-Hill 2021 • A. Bugini, C. Giardini, R. Pacagnella, G. Restelli "Tecnologia Meccanica vol I, Lavorazioni per fusione e deformazione plastica" Città Studi Edizioni 1995 • A. Bugini, C. Giardini, R. Pacagnella, G. Restelli "Tecnologia Meccanica vol II, Lavorazioni per asportazione di truciolo" Città Studi Edizioni 1995

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Prerequisites	None
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Specific educational objectives	The specific educational objectives include the understanding and knowledge of the fundamentals of material science and structural mechanics. The students will learn mechanical properties of engineering materials and structural elements and how they may be analyzed. This includes modelling abstractions, solution methods and the interpretation of results of relevant engineering mechanics problems.

Modul 1	**Mechanics of structures**
Dozent	Dr. techn. Thomas Moosbrugger
Wissenschaftlich-disziplinärer Bereich des Dozenten	
Unterrichtssprache	Deutsch
Sprechzeiten	18h (nach Vereinbarung: ThomasFranzXaver.Moosbrugger@unibz.it)
Wissenschaftlicher Mitarbeiter	-
Sprechzeiten	-
Auflistung der behandelten Themen	Kernthemen des Kurses (grundlegend für die Lernziele) • **-** Gleichgewicht von Kräften mit einem gemeinsamen Angriffspunkt an starren Körpern • - Bestimmung von Auflagereaktionen und inneren Kräften • - Kräftemittelpunkt, Masse und Schwerkraft • - Elementare Theorie von Zug/Druck, Biegung

	und Torsion • - Spannungen, Spannungsresultierende, Dehnungen und das Hooksche Gesetz Ergänzende Themen des Kurses • **-** Knickung • - Grundlegende Energiemethoden in Statik und Elastostatik • - Kinematische und statische Bestimmtheit • - Coulomb-Theorie der Reibung und Seilreibung • - Dünnwandige Druckbehälter Ergänzende Themen (nicht in der Vorlesung enthalten) • - Elementare Theorie der Plastizität • - Analyse von dickwandigen Zylindern • - Analyse von Platten und Schalen • - Zusammengesetzte Querschnitte
Unterrichtsform	Vorlesungen, Übungen

Modulo 2	**Scienza e Tecnologia dei materiali**
Docente	**Prof. Stefano Rossi PhD**, stefano.rossi@unibz.it, e stefano.rossi@unitn.it, 0471-017092, https://www.unibz.it/it/faculties/sciencetechnology/academic-staff/person/1075-stefano-rossi
Settore scientifico disciplinare del docente	ING-IND/22
Lingua ufficiale del corso	Italiano
Orario di ricevimento	18 h - prima delle lezioni ed esercitazioni
Collaboratore didattico (se previsto)	n.d.
Orario di ricevimento	13:00 – 14:00
Lista degli argomenti trattati	Durante il corso verranno considerati i seguenti aspetti: • **Introduzione**: i materiali e il loro utilizzo nei prodotti industriali • **Le basi delle proprietà di interesse tecnologico dei materiali**: • classi di materiali e loro proprietà caratterizzanti; • relazioni generali fra microstruttura e proprietà; • accenni di termodinamica delle trasformazioni di stato. • Il comportamento meccanico dei diversi tipi di materiali. • **I materiali metallici**: • generalità sulle leghe ferrose; • le leghe non ferrose. • Lavorazioni e trattamenti termici dei materiali metallici. • **I materiali ceramici e vetro**:

	• Ceramici: produzione ed utilizzo; ceramici refrattari. • La produzione di componenti in vetro. • **I materiali polimerici**: • produzione e proprietà dei polimeri; • lavorazione ed utilizzi dei materiali polimerici. **I materiali compositi:** • produzione, proprietà ed utilizzi dei materiali compositi. **Le normative nel campo dei materiali**: come si leggono e come si utilizzano
Attività didattiche previste	Il corso si basa su lezioni frontali in aula tenute dal docente. Le lezioni verranno quindi integrate con esercizi in aula e la proiezione di video che verranno commentati dal docente. Si cercherà di stimolare gli studenti a svolgere autonomamente alcuni esercizi e prove in modo da avere una valutazione dell'autoapprendimento. Generalmente si utilizzeranno presentazioni PowerPoint che verranno fornite agli studenti come materiale traccia per lo studio.

Learning outcomes	**<u>Module I Mechanics of structures:</u>** <u>Knowledge and understanding:</u> 1. Knowledge and understanding of the fundamentals of structural mechanics. <u>Applying knowledge and understanding:</u> 2. Applying theoretical methods to analyze engineering structures and structural systems. <u>Making judgments:</u> 3. Analyzing structural engineering devices/systems requires a deep understanding and the ability to show judgment regarding methods, results and designs. <u>Communication skills:</u> 4. Communication skills to convey and transfer structural mechanics knowledge. 5. Communication skills to interpret results of structural mechanics analyses and their consequences with respect to design. <u>Ability to learn:</u> 6. Learning skills to study independently the large and complex field of structural mechanics for specific

applications beyond this lecture.

Module II Material Science and Technology:

Knowledge and understanding:

1. Knowledge and understanding of the different properties of materials and different technologies and production processes.

Applying knowledge and understanding:

2. Applying knowledge and understanding through the development of skills and the ability to choose the suitable materials and the technology for a particular industrial product. In addition, the students should develop the ability to apply the knowledge on the behavior of materials in the performance of laboratory technological tests.

Making judgments

3. Connect the properties of different materials with their microstructure; capacity to evaluate the experimental data obtained in laboratory tests.

Communication skills

4. … to present the acquired skills with their own lexicon of the discipline and to be able to prepare a technical report about material tests.

Ability to learn

5. Acquire skills to deepen the topics covered during the course in order to apply them to simple practical cases.
6. Acquire the ability to interpret experimental test data obtained in material characterization tests.

Assessment

Module I Mechanics of structures:
Formative assessment:

Formative Bewertung (nicht Teil der Note)

Form	Dauer	Nr. Lernergebnisse
Übungen im Hörsaal	Im Laufe der Übungseinheiten, 20%	1-5

Summative Bewertung (Zusammensetzung der Note)

Form	Dauer	Nr. Lernergebnisse
Mündliche Prüfung (80%, In der Kleingruppe)	60 min	1-5

Module 2 Material Science and Technology:

Formative assessment:

Form	Length /duration	ILOs assessed
Exercises in the lecture hall	In the process of the exercises sessions	1-5

Summative assessment:

Form	Length /duration	ILOs assessed
Written exam	2 h	1,2,3,4,5

Assessment language

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